MID-TERM EXAM
BMEGEÁTMW19 Aerodyn. & Appl. for Vehicles 29th Nov. 2017.

available time: **90 min**.

NAME:…… NEPTUN code:……..

PLEASE READ CAREFULLY THE QUESTIONS!

TAKE CARE OF YOUR HANDWRITING!

GIVE YOUR ANSWER IN A SHORT & CLEAR FORMAT!

TRY TO POINT TO THE MAIN ESSENTIALS ONLY!

USE SKETCHES IF NEEDED!

THERE IS ENOUGH FREE SPACE LEFT for your SHORT/DENSE answers!

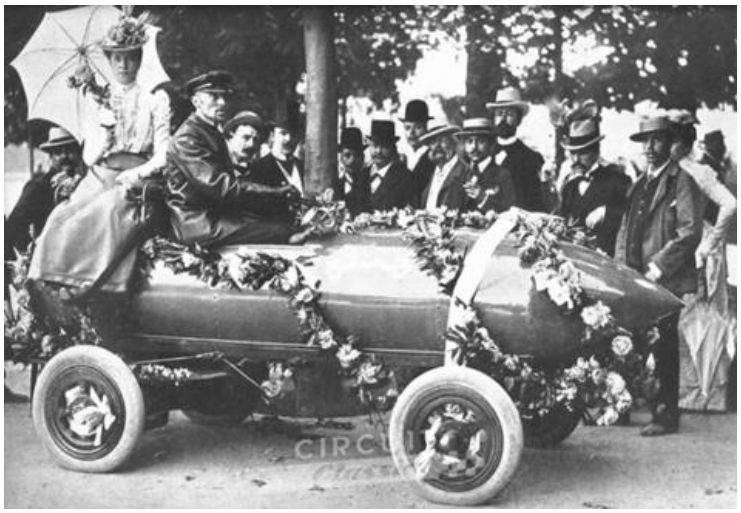
QUESTION TOPIC	max. points	achieved score
HISTORY		
1.	10	
2.	10	
BASICs		
3.	10	
4.	10	
5.	10	
PASSENGER CARS		
6.	10	
7.	10	
8.	10	
9.	10	
10.	10	
ADDITIONAL QUESTION for +10points		
+	10	
RESULT	Σ100	Σ……. =……..%

1)HISTORY

Fill in the table below with the <u>names</u> of the four main periods of history of aerodynamic developments and indicate the approximate <u>time intervals</u>, too!

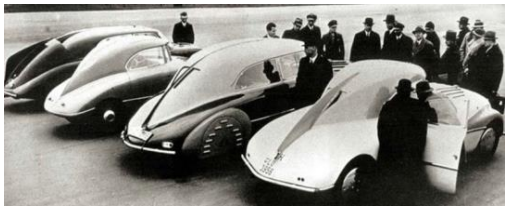
PERIODs	NAME of the PERIOD	time interval: ? from approx. year/decade ? to approx. year/decade
I.		
II.		
III.		
IV.		

The "La Jamais Contente" (="The Never Satisfied") was the first automobile to break the 100kmh (62 mph) record, in 1899.
<u>Explain the disadvantages of using this torpedo-shaped vehicle!</u>



2)HISTORY

Pál (Paul) Járay is the most famous aerodynamicists of the **II. period in the history of aerodynamic developments.**



<u>Explain his idea!</u> What are the <u>main characteristics</u> of this period? List/sketch/denote famous vehicles that are designed based on his idea!

3)BASICS

The $\underline{F}$ aerodynamic force acting on a vehicle is defined as being the sum of the $\underline{F_p}$ pressure based force and the $\underline{F_f'}$ viscous force:

$$\underline{F} = \underline{F_p} + \underline{F_f'}$$

Derive / transform this equation and explain shortly the main steps of derivation: please show how the c_p pressure coefficient and the c_f' wall (skin) friction coefficient are included! (i.e. How do we get the final form of this equation shown below.)

The final form of the equation:

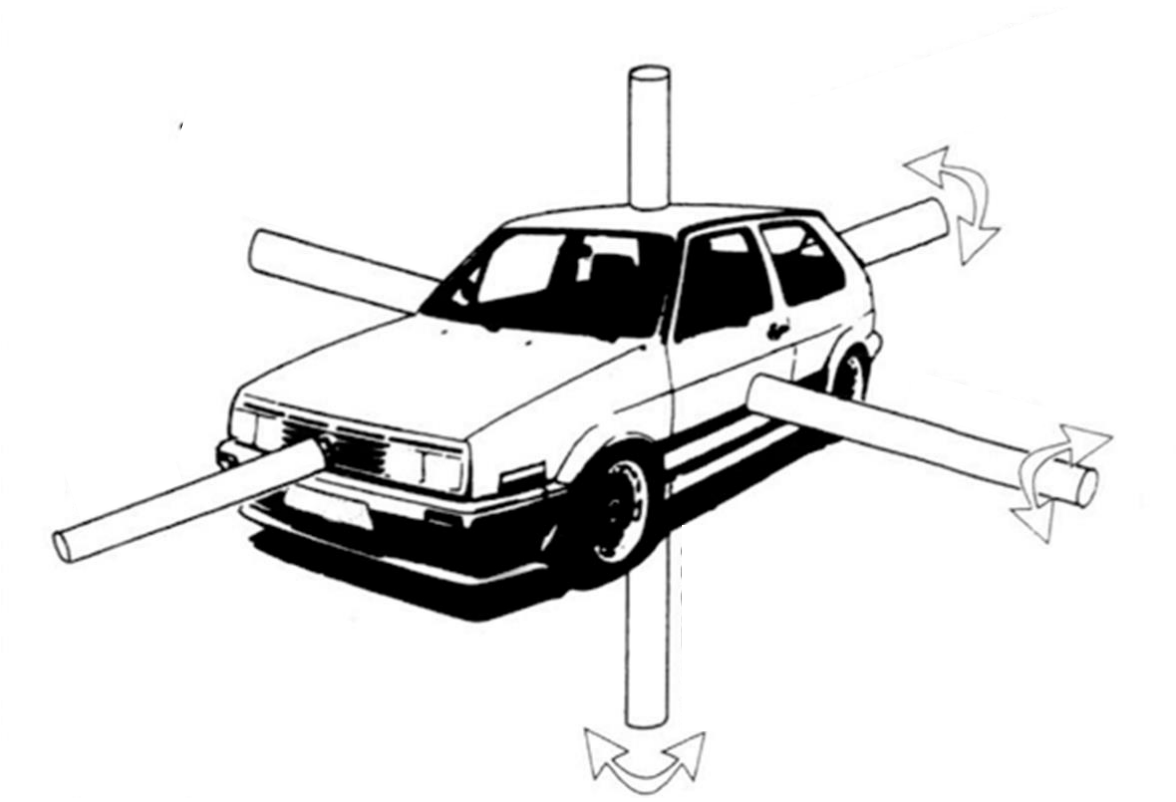
$$\underline{F} = \frac{\rho}{2} v_\infty^2 \cdot \left[-\int_A c_p \, d\underline{A} + \int_A c_f' \, \underline{e} \left| d\underline{A} \right| \right]$$

Define the c_p pressure coefficient and the c_f' wall friction coefficient with their formula and indicate their range, magnitude, min/max. limits!

pressure coefficient	wall friction coefficient
$c_p =$	$c_f' =$
range, magnitude, min/max limit values:	range, magnitude, min/max limit values:

4)BASICS

Define the coordinate system: denote the axes (x;y;z) in the figure below!
Define in the figure the force and moment components!



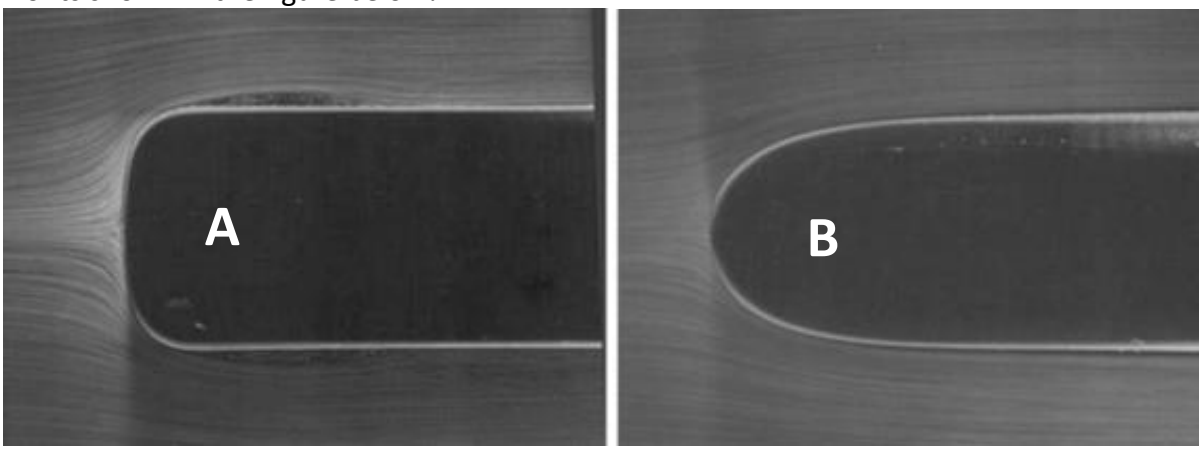
Define in the table below the drag, lift & side force coefficients with their formula! Define in figure the A_{ref} projected frontal area, and the v_∞ relative flow velocity vector, too!

drag coeff.	lift coeff.	side(yaw) force coeff.
$c_D =$	$c_L =$	$c_S =$

5)BASICS

What are main the consequences on drag and lift of the rounding-up of the front of a bluff body?

Explain the differences (from aerodynamic viewpoint) between the A) and B) rounded up fronts shown in the figure below!



6)PASSENGER CARS

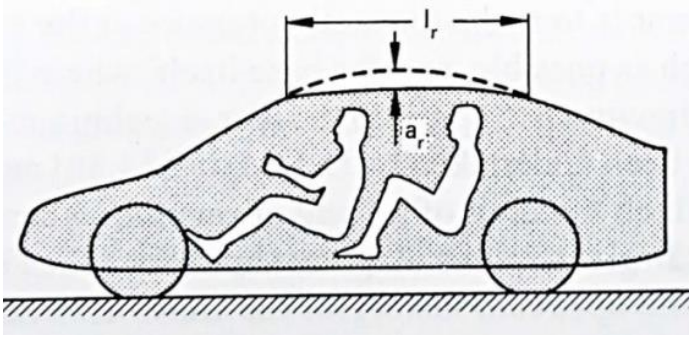
The rear spoiler is deleted from this vehicle image.

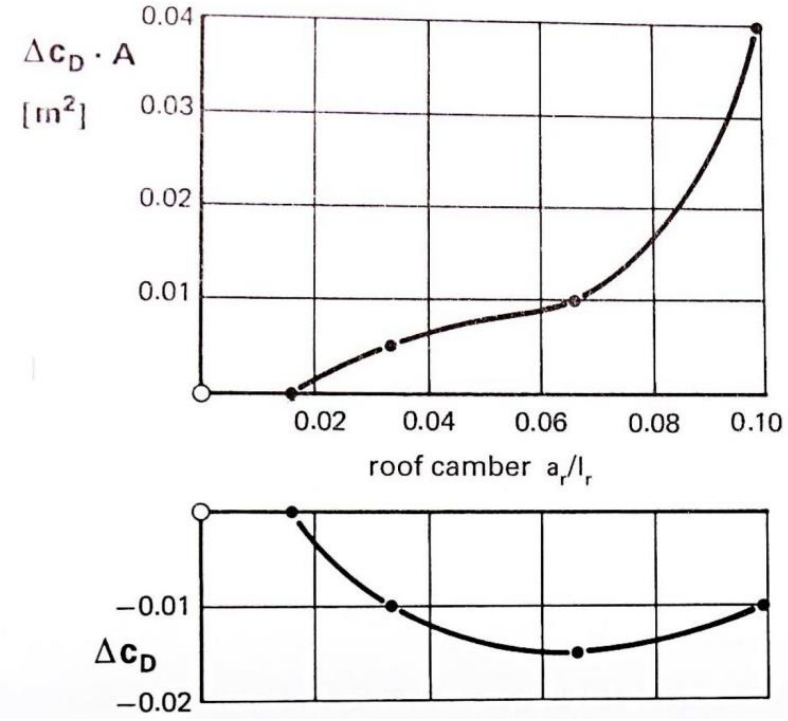
Add a **rear spoiler** to this (Honda Civic 2017 hatchback) vehicle!

Explain and show the working mechanism, how would your rear spoiler influence the drag and lift! (Analyse and explain the effect with drawing streamlines around the rear and indicate the change in rear pressure coefficient values!

7)PASSENGER CARS

Analyse the influence (advantages / disadvantages) of the roof cambering on drag and lift!



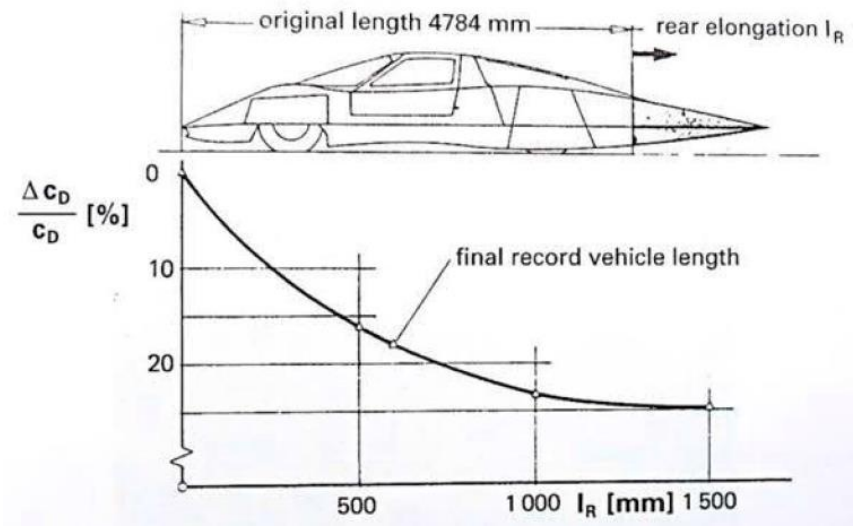


8)PASSENGER CARS

Boat-tailing / tail-elongation / truncated tail: Explain its mechanism with the help of a sketch of streamlines, separation bubble etc. around the rear section.

How does the truncated rear effect on the drag, lift and side forces & moments?

Why only truncated tails are used in today cars?



9)PASSENGER CARS

List at least 3 aerodynamic elements that are visible on your card!

Card Nr. **NAME / TYPE /:** **A B C D** **1-2-3-4-5-6-7-8-9**
Name at least 3 aerodynamic elements that are visible:
1.
2.
3.
(4.)
(5.)

Select ONE from the elements of the above named ones, and analyse its influence on the drag and on the lift coefficient of this vehicle! use arrows (🡅? or 🡇?)

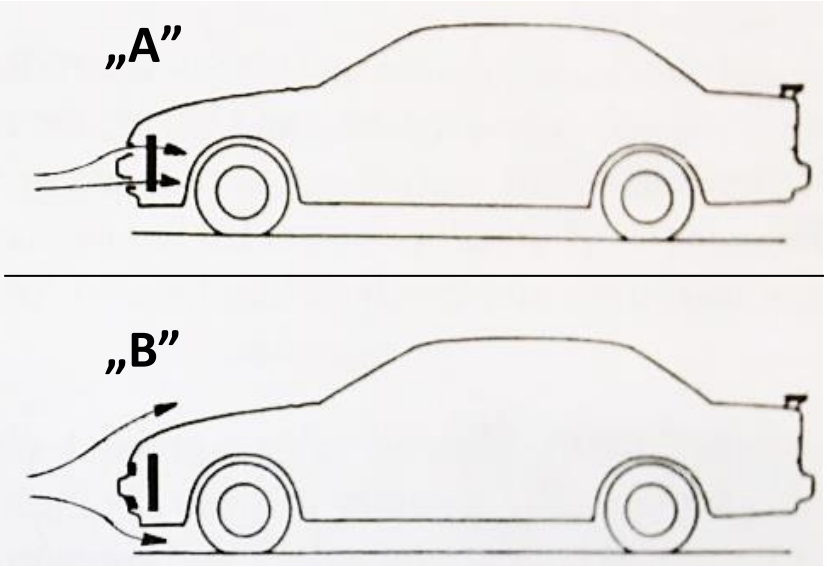
influence on DRAG	influence on LIFT

10) PASSENGER CARS

A passenger car (A_{ref}=2m^2) moves at a speed of v=216 km/h on a straight, horizontal motorway in a still ambient! Conditions: no wind, ρ_{air}=1,2kg/m^3, p_0=10^{5}Pa, t_0=20°C).

In case A) the front grill (cooling air port) is open, while in case B) it is closed. Table below contains measured data of the drag, front and rear lift and pitching moment coefficients for both cases.

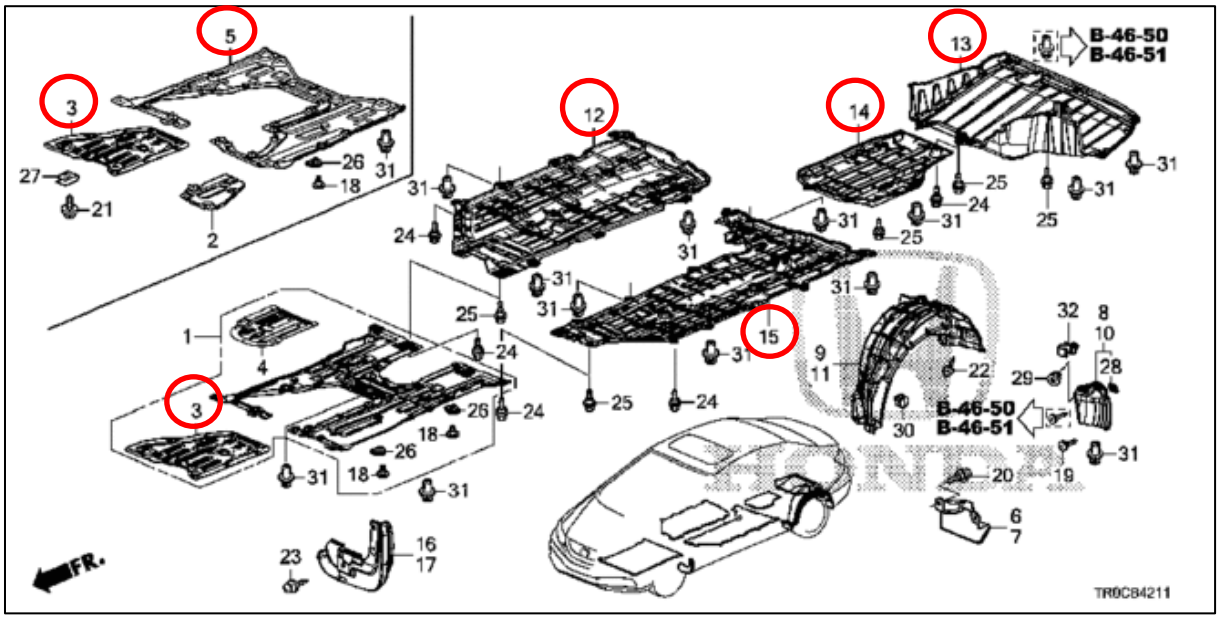
	„A”	„B”
	Cooling air ports	
	Open	Closed
C_D	= 0.34	0.30
C_{LF}	= 0.15	0.02
C_{LR}	= 0.08	0.13
C_M	= 0.03	0.06



Define and calculate the difference in aerodynamic drag forces [N] and the difference in aerodynamic power losses [W] between cases A) and B) shown in figures above!

+) ADDITIONAL QUESTION for +10points

The figure below shows the underbody covering element parts assembly with prizes for a **Honda Civic 2015 sedan**.



Position	Nr.	Name of the element	Prize
FRONT UNDERBODY:			
	3.	Underbody engine cover plate front lower engine cover	$16
	5.	Underbody engine cover plate main lower engine cover	$22
MID SECTION UNDERBODY:			
	12.	Underbody mid floor cover side rights mid section	$32
	15.	Underbody mid floor cover side left mid section	$45
REAR UNDERBODY:			
	13.	Underbody rear floor cover element for lower rear diffuser	$30
	14.	Underbody rear floor cover element - for lower fuel tank	$14

Select element(s) from the listed ones that are needed to buy & mount to this vehicle to get the <u>maximum downforce</u>!

Elements selected (list with Nr of the element(s)):……..
Total prize:……USD

Explain shortly the influence of underbody coverings on the underbody flow!